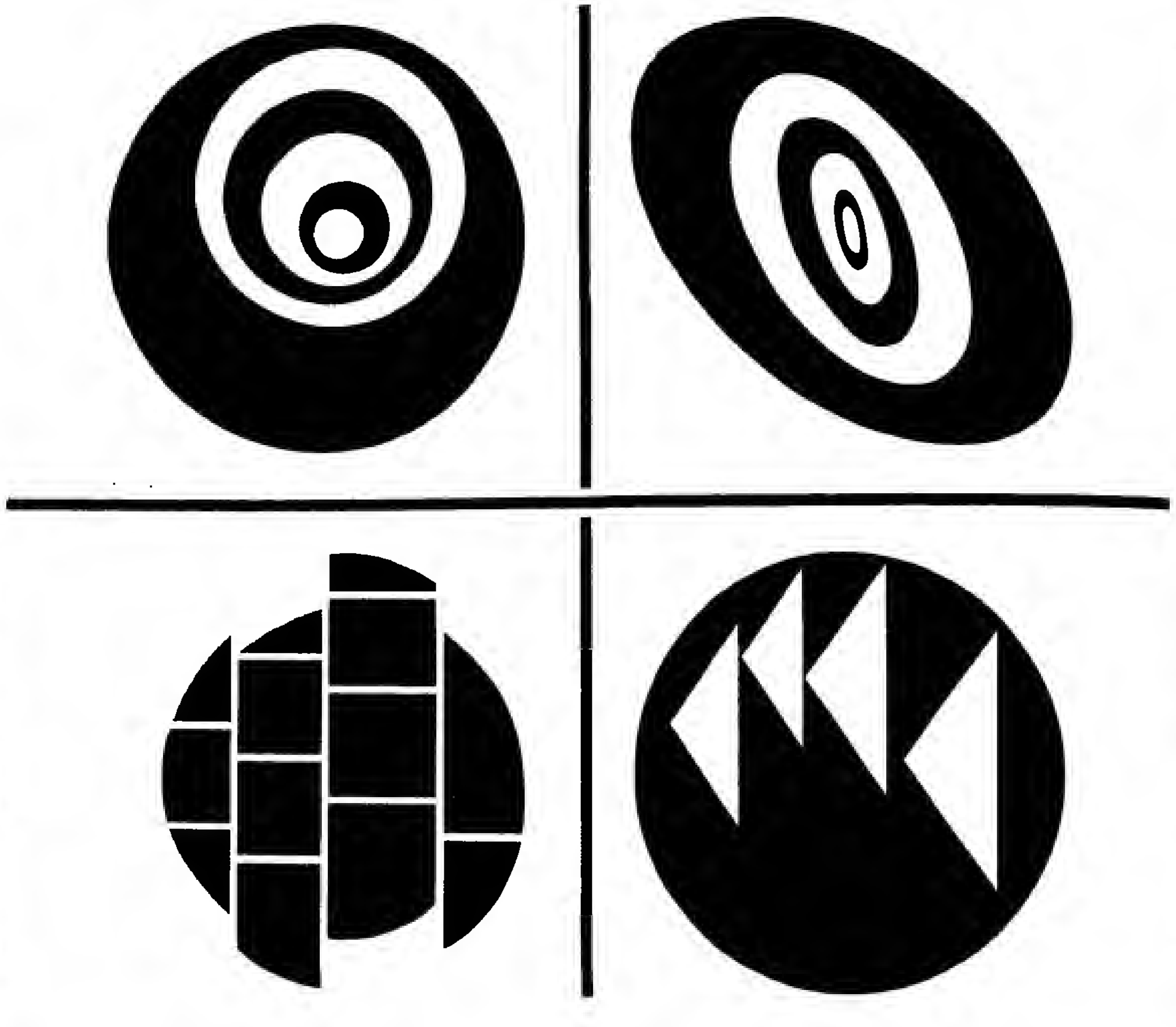
EOS
TRANSACTIONS, AMERICAN GEOPHYSICAL UNION
VOLUME 62 NUMBER 39 SEPTEMBER 29, 1981



EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION VOL. 62, NO. 39, PAGES 881-888 SEPTEMBER 29, 1981

Particles and Fields—Interplanetary Space

5100 Electromagnetic radiation
4.5 kHz GROUND HISS AND FIELD ALIGNED CURRENT IN THE DAYSIDE CUSP
P.L. Dowden (Department of Physics, University of Otago, Dunedin, New Zealand) N.G. Kleimenova (Institute of Physics of the Earth, Bolshaya Gruzinskaya, 10, Moscow, U.S.S.R.)
A slowly varying background noise or 'hiss' in the 4-5 kHz band is observed at Lake Vanda, Antarctica (80°S, 1977). During summer the noise is maximum at about 08 LMT (local magnetic time) and minimum at 20 LMT. During winter the times of maximum and minimum are interchanged (anti-phase variation). During low Kp (average = 1+), noise is maximum at about 10 LMT and minimum at 20 LMT. During high Kp (average = 2+) maximum is at about 00 LMT and minimum at 12 LMT. Noise occurrence is independent of the polarity of the Bz component of the IMF (interplanetary magnetic field) but absent when |Bz|>5-6nT. Noise occurrence is strongly dependent on the IMF By component: By was negative for 82% of the days of noise presence and positive for 91% of the days of absence. These properties fit the proposal that this noise is Čerenkov radiation from the precipitating soft electrons which constitute the upgoing field aligned current deduced from IMF measurements in the dayside cusp. (Hiss, field aligned current, cusp).
J. Geophys. Res., Blue, Paper 1A1282

2340 Shock waves
ACCELERATION OF ELECTRONS BY INTERPLANETARY SHOCKS
Douglas W. Potter (Space Sciences Laboratory and Department of Physics, University of California, Berkeley, California 94720)
Although proton acceleration often is observed at interplanetary shocks, electron acceleration rarely has been reported. In contrast, many of the shocks identified so far by instruments on the ISEE-1 spacecraft show significant increases in the spin averaged electron flux at energies greater than 2 keV. At 2 keV, the spin averaged electron flux usually increased by a factor of 2 to 3 but on several occasions increased to more than 10 times its preshock level. Often, the behavior of the electrons is similar to higher energy (several MeV) proton spikes: the electrons are field aligned before the shock and are highly anisotropic with the flux maximum perpendicular to the magnetic field at the shock and immediately after the shock. This is the signature of the shock drift model of acceleration where the gradient in the magnetic field causes the particles to move in the direction of lower potential energy in the convection electric field.
Given that a primary assumption of the shock drift model is that the gyroradius is much larger than the shock thickness, and that this assumption is invalid for electrons, it is initially surprising that electrons and ions can act similarly at shocks. A closer look shows that by conserving the first adiabatic invariant, electrons obey the same expressions for reflected and transmitted particles as ions. (Particle acceleration, shock waves)
J. Geophys. Res., Blue, Paper 1A2327

5370 Solar wind magnetic fields
The IMF Sector Pattern through the Solar Minimum: Two Spacecraft Observations during 1974-1978.
U. Villante (Istituto di Fisica, Università, L'Aquila), F. Mariani (Istituto di Fisica, Università, Roma), N.F. Ness (NASA/GSFC, Greenbelt, MD), P. Francia (Istituto di Fisica, Università, L'Aquila).
The hourly average values of the IMF as observed by Helios 1 and Helios 2 in the period of time December 1974 through March 1978 have been examined to deduce how the sector pattern seems to evolve with time and heliographic latitude (±7.2° from the solar equator). The dominant two sector pattern observed since 1972 extends to the whole declining phase of solar cycle 20 and the corresponding source regions seem to corotate with an angular velocity smaller than the equatorial one.
The latitudinal dependence of the IMF polarity (outward field lines below the solar equator) is observed, with occasional deviations, through the whole period of time and becomes particularly clear in the first half of 1977. Gross scale implications for the shape and location of the sector boundary surface are discussed.
(solar wind, magnetic fields, sector structure)
J. Geophys. Res., Blue, Paper 1A1186

5380 Solar wind plasma
SOLAR WIND HELIUM IONS: OBSERVATIONS OF THE HELIOS SOLAR PROBES BETWEEN 0.3 AND 1 AU
E. Marsch (Max-Planck-Institut für Aeronomie, 3411 Katlenburg-Lindau 3, Federal Republic of Germany), K.-H. Mühlhäuser, R. Rosenbauer, R. Schwenn, and F. M. Neubauer
A survey of solar wind helium ion velocity distributions and derived parameters as measured by the Helios solar probes between 0.3 and 1 AU is presented. Nonthermal features like heat fluxes or He²⁺ double streams and temperature anisotropies have been frequently observed. Fairly isotropic distributions have only been measured close to sector boundaries of the interplanetary magnetic field. At times in slow solar wind persistent double humped helium ion distributions constituting a temperature anisotropy $T_{\parallel}/T_{\perp} > 1$ have been reliably identified. Distributions in high speed wind generally have small total anisotropies ($T_{\parallel}/T_{\perp} \gtrsim 1$) with a slight indication that in the core part the temperatures are larger parallel than perpendicular to the magnetic field, in contrast to simultaneous proton observations. The anisotropy tends to increase with increasing heliocentric radial distance. The average dependence of helium ion temperatures on radial distance from the sun is described by a power law $\sim R^{-\beta}$ with $0.7 \leq \beta \leq 1.2$ for $T_{\parallel}$ and $0.87 \leq \beta \leq 1.4$ for $T_{\perp}$. In fast solar wind the $T_{\perp}$ profile is compatible with nearly adiabatic cooling. Pronounced differential ion speeds $\Delta v_{\alpha p}$ have been observed with values of more than 150 km/s near perihelion (0.3 AU). In fast streams $\Delta v_{\alpha p}$ tends to approach the local Alfvén velocity v_A, whereas in slow plasma values around zero are obtained. Generally the differential speed increases with increasing proton bulk speed and (with the exception of slow plasma) with increasing heliocentric radial distance. The role of Coulomb collisions in limiting $\Delta v_{\alpha p}$ and the ion temperature ratio T_{α}/T_p is investigated. Collisions are shown to play a negligible role in fast solar wind, possibly a minor role in intermediate speed solar wind and a distinct role in low speed wind in limiting the differential ion velocity and temperature.
J. Geophys. Res., Blue, Paper 1A1364

5380 Solar wind plasma
SOLAR WIND PROTONS: 3-D VELOCITY DISTRIBUTIONS AND DERIVED PLASMA PARAMETERS MEASURED BETWEEN 0.3 AND 1 AU
E. Marsch (Max-Planck-Institut für Aeronomie, 3411 Katlenburg-Lindau 3, Federal Republic of Germany) K.-H. Mühlhäuser, R. Schwenn, H. Rosenbauer, W. Pilipp, and F. M. Neubauer
A survey of solar wind 3-D proton velocity distributions as measured by the Helios solar probes between 0.3 and 1 AU is presented. A variety of nonthermal features like temperature anisotropies, heat fluxes or proton double streams has been observed. The relative speed of the second proton component increases on the average with increasing wind speed and decreasing heliocentric radial distance and shows a correlation with the local Alfvén speed. A marked anisotropy in the core of proton distributions with a temperature larger perpendicular than parallel to the magnetic field ($T_{\perp c} > T_{\parallel c}$) is a persistent feature of high speed streams and becomes most pronounced in the perihelion (∼ 0.3 AU). Fairly isotropic distributions have only been measured very close to and directly at magnetic sector boundaries. Low and intermediate speed distributions usually show a total temperature anisotropy $T_{\parallel}/T_{\perp} > 1$ frequently caused by "high energy shoulders" or a resolved second proton component. No clear radial gradient of the temperature anisotropy could be established in these cases. The average dependence of the proton temperature on heliocentric radial distance is given by a power law $R^{-\alpha}$, where $\alpha \lesssim 1$ for $T_{\parallel p}$ and $0.7 < \alpha < 1$ for $T_{\perp p}$ are compatible neither with isothermal nor adiabatic expansion. Flattest radial temperature profiles are obtained in high speed streams. These observations indicate that local heating or considerable proton heat conduction occurs in the solar wind. Some consequences of nonthermal features of proton distributions for plasma instabilities are discussed as well as kinetic processes which may shape the observed distributions.
J. Geophys. Res., Blue, Paper 1A1363

Particles and Fields—Ionosphere

5520 Electric fields
MAGNETIC DECLINATION CONTROL OF THE EQUATORIAL F-REGION DYNAMO ELECTRIC FIELD DEVELOPMENT AND SPREAD-F
M.A. Abdu (Instituto de Pesquisas Espaciais, Conselho Nacional de Desenvolvimento Científico e Tecnológico, 12200 - São José dos Campos, SP, Brasil), J.A. Bittencourt and I.S. Batista
We have carried out a comparative study of the evening prereversal enhancement in the equatorial F-region vertical ionization drift velocities (V_z) over Fortaleza (4°S, 38°W), Brazil, and Jicamarca (12°S, 77°W), Peru, two magnetic equatorial stations in the American zone. The results show profound dissimilarities in the seasonal trends in the time and width of the V_z prereversal peak, that reflect in the spread F characteristics as well, at the two stations. The dissimilarities are shown to be arising mainly from the difference in the magnetic field declination angles that causes differences in the conjugate E region sunset durations and, hence, in the F-region polarization electric field development rates, at the two stations. (F-layer dynamo, spread F, magnetic declination).
J. Geophys. Res., Blue, Paper 1A1374

5530 High-latitude ionospheric currents
SPECTRAL STUDIES OF F REGION IRREGULARITIES IN THE AURORAL ZONE
O. Hamelin (L.E.P.S.T., Université de Toulon, le Pradet, Bd des Armaris, 83100 Toulon, France), J.F. Vuilain and M. Crochet
Auroral F region irregularities have been studied with the HF coherent radar system SAFARI at wavelengths of 10.5 and 7.0 meters. Their Doppler spectra exhibit large spatial and temporal variations which indicate that the phase velocity is related to the motion of the bulk plasma. This observation agrees with a production by low energy precipitations or plasma instabilities like cross-field instability or current-convective instability. Coordinated ground-based and satellite measurements are necessary to conclude definitely on the origin of these irregularities. (Auroral echo, plasma instabilities, F region).
Geophys. Res. Lett., Paper 1L1320

News

Neptune's Rotation Period Calculated

Three scientists at Kitt Peak National Observatory have calculated that Neptune's rotation period is 18.2 hours plus or minus 24 minutes. This, the most accurate estimate to date, takes planetologists one step closer to understanding the distant planet's structure and chemical composition. In addition, knowing the planet's rotation rate helps to understand better the forces that affect its atmosphere.

Michael J. S. Belton, Lloyd Wallace, and Sethanne Howard base their calculations on 300 observations made in 1980 in the infrared part of the electromagnetic spectrum.

The Kitt Peak researchers noted that because astronomers can only observe Neptune's cloud tops, measuring the exact length of a Neptunian day is extremely difficult.

Rapid Rise Predicted for Geologist Salaries

The number of geologists entering the earth science profession and their average salary will increase faster than for other natural and physical sciences during the next 2 decades, according to A. G. Unklesbay, executive director of the American Geological Institute (AGI). He is drafting for the National Academy of Sciences' Geological Sciences Board (*Eos, 62*, p. 107, March 17) a chapter on manpower needs in geology.

'AGI studies trends in geoscience education, and our records show that majors have doubled in the decade 1971–1980,' Unklesbay said. 'These studies are ongoing and the data for 1981 show this trend continuing.'

A study by Vina Associates also shows high salaries for geologists. The study reports that the median salary for 5-year earth scientists is $42,800.

Centenary Celebration

The British Natural History Museum, one of the world's leading taxonomic institutions, will celebrate 100 years at South Kensington with two Centenary Open Days, November 18 and 19. More than 100 exhibits will display highlights from the museum's scientific work in mineralogy, paleontology, entomology, botany, and zoology and from the museum's supporting library services.

Admission tickets will not be issued, but those who wish to attend should contact the Open Days Office, British Museum (Natural History), Cromwell Road, London, England SW7 5BD (telephone: 01-589 6323, extensions 667 and 205).

Senate Confirms Peck Appointment

The U.S. Senate confirmed on September 18 the appointment of Dallas L. Peck as director of the U.S. Geological Survey. Peck, chief geologist at the USGS since 1977, is a Fellow of AGU and a recent past president of AGU's Volcanology, Geochemistry, and Petrology section.

The confirmation follows by 3 months President Reagan's announcement of his intention to nominate Peck.—*BTR*

Digitized Snow and Ice Cover Data Base Now Available

The NOAA/NESS Northern Hemisphere Weekly Snow and Ice Cover Charts have now been digitized for the period 1966–1980 and put on computer-compatible tape. The digitizing grid consists of an 89 × 89 element matrix covering the entire northern hemisphere. The latitude and longitude center point and the true surface area of each grid box are stored in the data archive. A grid box that is 50% or more snow and/or ice covered is considered to be completely covered. The land and water geography are also stored in the data archive.

With this digitized data it is possible to create several products. Snow- and ice-covered areas, both weekly and monthly, can be calculated. Digitized weekly and monthly snow and ice cover maps can be generated. Snow and ice cover frequency and anomaly maps are other possibilities. All these products can be created for any northern hemispheric region that a researcher or user is interested in. The data base will be updated yearly. Copies of the computer tape and the accompanying documentation at a cost of $72 may be ordered from Bruce Needham, NOAA/EDIS, Room 100, World Weather Building, Washington, D. C. 20233.

Geophysicists

Richard A. Anthes has been appointed director of the Atmospheric Analysis and Prediction Division of the National Center for Atmospheric Research (NCAR) in Boulder, Colo. For the past 4 years he has been a professor in the College of Earth and Mineral Sciences at the Pennsylvania State University. He is currently chairman of the National Academy of Sciences' Panel on Mesoscale Processes and is a member of the academy's Committee on Atmospheric Sciences.

Bauer

Siegfried J. Bauer, an AGU Fellow, has accepted the chair of meteorology and geophysics at the University of Graz, Austria. He succeeds his former teacher *Otto Burkard*. Bauer has returned to his alma mater after more than 25 years of research in the United States, including 20 years at the NASA/Goddard Space Flight Center, where he last served as associate director of sciences.

George H. Ludwig is the now director of NOAA's Environmental Research Laboratories. An authority on remote sensing, he is the former director of operations for NOAA's National Earth Satellite Services.

EOS

TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

The Weekly Newspaper of Geophysics

Send double-spaced manuscripts (four copies) to *Eos*, AGU, 2000 Florida Avenue, N.W., Washington, D.C. 20009, or send them directly to one of the associate editors with a copy to the above address.

Eos, Transactions, American Geophysical Union (ISSN 0096-3941) is published weekly by the American Geophysical Union from 2000 Florida Avenue, N.W., Washington, D. C. 20009. Subscription available on request. This issue $5.00. Second-class postage paid at Washington, D. C., and at additional mailing offices.

Cover. The new oceanographic research ship HMAS *Cook* enters Sydney Harbor to commence work-up for oceanographic cruises. The 97-m ship, designed to satisfy the Royal Australian Navy (RAN) Research Laboratory's needs for physical and acoustical oceanography, will undertake a series of oceanographic cruises around Australia. Earth scientists will play a major role in this effort to understand the ocean and the seafloor around Australia. (Photo courtesy of Ian S. F. Jones, Head, Ocean Sciences Group, Department of Defence, RAN Research Laboratory, Australia.)

New Publications

Estuarine and Wetland Processes

Peter Hamilton and Keith B. Macdonald, Plenum, New York, xi + 653 pp., 1980, $69.50.

Reviewed by Howard J. Freeland

The estuarine environment, including the wetlands, forms an interface between the engineering activities of man and the ocean. Many estuaries occur in highly populated and industrialized regions, and the demands placed on estuaries by recreation, waste disposal (from both cities and industrial activity), and fishing are invariably incompatible. For this reason, interest in this environment is generating a steadily increasing amount of research.

This volume results from a workshop on 'Estuarine and Wetland Processes and Water Quality Modeling,' held in New Orleans, June 1979. The editors state, in the preface, that the 'contents of this volume have been selected from the workshop papers.' This gives the volume an edge over similar volumes of proceedings in that the papers are longer and generally more useful, and several treat more substantial areas of research than is usual.

The volume was prepared to camera-ready stage by the scientific editors, and some aspects of the editing detract from the volume. In several of the physical papers, equations are typed unconventionally and sometimes badly. For example, lines are typed through the middle of subscripts and superscripts, hand drawn integral signs and parentheses are very messy in a number of places (a few dollars invested in a single sheet of Letraset would have prevented that problem), and in a paper by Officer pages have been interchanged. Beyond the presentation there are scientific problems that, in my opinion, should have been caught by the editors. For example, in the paper by Officer, 'Box Models Revisited,' equation (3) is in two parts:

$$E_{ij} = E_{ji}$$

and

$$E_{ji} = \frac{s_i}{s_j - s_i} R,$$

and it appears to me that the two parts are incompatible. On page 17, Gardener et al. state that in Long's model of fjord circulation he assumes no flow in the lower layer. That is not correct: He assumes zero pressure gradient in that layer, which is quite different.

The material in the volume is somewhat variable in quality. Many of the papers are less than inspiring. However, the review of 20 years of speculation and research on salt marshes is well written and makes fascinating reading. I was also impressed by several papers of an applied nature; for example, April and Raney present an excellent case study of an operational storm surge and flooding numerical model.

The first paper in the book, 'Turbulent Processes in Estuaries,' by Garder et al., is also an interesting and useful paper. However, the authors appear to assume that the only significant source of energy for turbulent processes in estuaries is the tide. I agree that this is true in some estuaries, but I certainly cannot agree in general. Surely there is sufficient evidence that the wind can generate a considerable amount of turbulence. Their second conclusion seems excessively broad considering that they examine data from only two estuaries.

Butler presents a paper that describes both the development and the applications of a two-dimensional model of ocean/estuarine exchange. The model has been extensively tested and is a useful tool for addressing problems associated with various types of coastal projects. It is a pity that a good paper has in this case been spoiled by sloppiness. Two figures, 11 and 17, are virtually impossible to read, and the scale on Figure 22 does not indicate any units.

Another paper that was basically interesting but left me wondering was Blanton's paper on the 'Transport of Freshwater off a Multi-Inlet Coastline.' The units M^3H_2O m^2 are presented without explanation.

In summary, the volume treats an important subject, and there is sufficient material of a high standard that it warrants inclusion in any professional oceanographic or marine biological library. For my own personal collection, I would prefer to order reprints of individual papers.

Howard J. Freeland is with the Institute of Ocean Sciences, Sidney, British Columbia, Canada.

Geothermal Resources

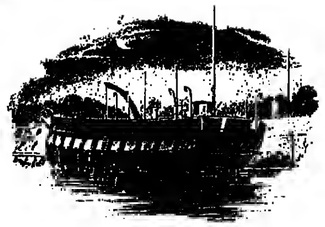
Robert G. Bowen, John Wiley, New York, xi + 243 pp. 1979, $54.95.

Reviewed by David D. Blackwell

Up-to-date discussions of the developments in geothermal energy are not common, and so any new book on the subject might fill an important gap in available summaries of the subject. The outline of *Geothermal Resources* looks fairly complete. Chapters are devoted to discussions of The Geysers, California, New Zealand, and Italy, and brief discussions of other areas such as well exploration, drilling, and development aspects. The book is aimed toward a general audience because there is a long glossary at the end of the book. This orientation causes problems because the author tries to be relatively technical at the same time. However, upon closer reading it is clear that the coverage of the topics is very superficial and skimpy. The coverage of most of the subjects within the chapters is very irregular and quite out of date. Some subjects are discussed in several different chapters for no obvious reason. The most extensive, recent set of publications on geothermal energy is the three-volume *Proceedings of the Second U.N. Symposium on the Development and Use of Geothermal Resources*, held in San Francisco in 1975 (U.S. Government Printing Office, 1976). None of this material is mentioned in the book. Publications of the Geothermal Resource Council (P.O. Box 98, Davis, California, 95616) contain numerous papers dealing with geothermal energy in the United States, and none of this material is referred to in this book either. This superficial and skimpy text is not helped by the figures. Most of the maps are crude line drawings and do not include scales. For all the technical deficiencies of the figures, however, the text is much worse. There is no evidence that the text has been edited either for English or by someone familiar with geothermal energy: For example, on p. 10 it is stated that the average crustal thickness for the earth is 35 km. Similarly, a typical sentence in a section discussing limits on drilling technology is 'at present drilling

(cont. on page 692)

The Oceanography Report



H.M.S. CHALLENGER, 1865.

The Oceanography Report

The local point for physical, chemical, geological, and biological oceanographers.

Associate Editor: Arnold L. Gordon, Lamont-Doherty Geological Observatory, Palisades, New York, 10964 (telephone 914-359-2900, ext 325)

Future of the U.S. Academic Research Fleet

Marcus G. Langseth

In recent years, the U.S. oceanographic community has suffered a significant reduction in the size of its research fleet; if funding for the research fleet does not increase, the academic community may lose one or two more of its larger ships during the next 5 years. Federal agencies that sponsor research at sea, primarily the National Science Foundation (NSF) and the Office of Naval Research (ONR), are deeply concerned about the diminishing U.S. oceanographic capability, and they have requested a special study of the problem by the Ocean Science Board of the National Academy of Sciences. This study, under the direction of Michael Mullin of the Scripps Institute of Oceanography, is nearing completion, and a report is expected soon. In the following, I try to identify some of the reasons for this reduction, although the primary reason is not hard to anticipate (operating costs have been rising much faster than operating funds over the past 10 years).

Composition of the Fleet

The academic community depends primarily on the UNOLS fleet to do its science at sea. UNOLS is an organization of institutions that operate research vessels; it serves as a focus for fleet planning, coordination of schedules, and equipping of the research vessels. The present composition of the UNOLS fleet is shown in Table 1 and is compared with that of 1973.

The two largest ships of the present fleet, Woods Hole's R.V. *Knorr* and Scripps' R.V. *Melville*, are 245 ft long. These ships are capable station-keeping platforms with excellent range and with the capability to handle heavy equipment. They carry a large complement of scientists in relative comfort and have been the backbone of large programs, such as GEDSECS and PDLYMODE. Four of the UNOLS ships are about 210 ft long. Three of these are Navy-built AGOR class vessels, operated by Lamont-Doherty, Scripps, and the University of Washington; the fourth is *Atlantis II*, built by the National Science Foundation and operated by Woods Hole. These ships have proven particularly effective for marine geological and geophysical investigations, having both range and seaworthiness. Two ships over 200 ft long, the *Gillis* of Miami and the *Verna* of Lamont-Doherty, were retired this past year.

A ship replacement program sponsored by the National Science Foundation in the 1970's provided the UNOLS fleet with three new 177 ft vessels of the so-called '*Oceanus* class.' Compared with the AGORs these ships have a limited range, but they provide seaworthy deep-sea platforms and have relatively low operating costs. The University of Miami's *Columbus Iselin*, which is only slightly smaller, was also built by the National Science Foundation. Completing the list of ships larger than 150 ft are the Navy-built *Gyre* and *Moana Wave*, Scripps' *New Horizon*, and Hawaii's *Kana Keoki*. Since 1978, the *Moana Wave* has been used exclusively by the Navy.

Nearly half of the ships in the fleet are 135 ft or smaller, have limited endurance and range, and are mainly used for coastal work. The two newest ships to enter the fleet, the *Cape Florida* and the *Cape Hatteras*, were built by the National Science Foundation in 1981 as Coastal Zone Research Vessels (CZRV) and replaced vessels at the operating institutions.

Although the *Glomar Challenger*, the deep-sea drilling ship, is not a UNOLS vessel, it should be included in any summary of the U.S. deep-sea capability available to the academic community. Plans are well underway to convert the *Glomar Explorer* to a second-generation drilling vessel in the mid-1990's to replace the *Challenger*. The *Challenger*'s operation is supported by the National Science Foundation and by international partners in the Deep-Sea Drilling Project. It is planned that the *Explorer*'s conversion and operating costs will be shared between the National Science Foundation, international partners, and a consortium of contributing oil companies. Thus, the *Glomar Explorer* could be regarded as the major addition, albeit a replacement to the *Challenger*, to the U.S. deep-sea capability planned for the 1990's.

The deep submersible *Alvin* and its tender *Lulu* is also a part of the U.S. marine research capability. The *Alvin* is operated by Woods Hole as a national facility. The sponsoring agencies are considering converting one of the ships in the 150–200 ft class to serve as a tender for *Alvin* and retire the *Lulu*, which is slow and limited in range and accommodations for multidisciplinary programs. This conversion would remove another general purpose research ship from the fleet. Table 1 shows that the mix of ships has changed over the past 8 years. The trend has been to retire larger blue-water ships and replace them with smaller vessels, cheaper and more suitable for near-shore work.

TABLE 1. Composition of UNOLS fleet in 1973 and 1981

Operator	Ship 1981	Ship 1973	Length, ft	Year Built	Desired Retirement*
Woods Hole Oceanographic Institution	*Knorr*	*Knorr*	245	1968	1999
	Atlantis II	*Atlantis II*	210	1883	1983
	Oceanus		177	1875	2005
		Chain	214	1944	1974
		Gosnold	99	1943	1973
Scripps Institution	*Melville*	*Melville*	245	1870	2000
	T. Washington	*T. Washington*	209	1965	1995
	New Horizon		170	1879	2008
	E.B. Scripps	*E.B. Scripps*	85	1865	1895
		Agassiz	180	1844	1974
		Oconostota	100	1844	1974
		Alpha Helix	133	1895	1995
Columbia University	*Conrad*	*Conrad*	209	1962	1992
		Verna	203	1823	1880
University of Washington	*Thompson*	*Thompson*	209	1965	1995
		Hoh	65	1943	1973
		Onar	85	1854	1994
University of Rhode Island	*Endeavor*		177	1978	2008
		Trident	180	1844	1974
Texas A&M University	*Gyre*		174	1973	2003
		Alaminos	180	1845	1976
Oregon State University	*Wecoma*		177	1975	2005
		Yaquina	180	1944	1974
University of Hawaii	*Kana Keoki*	*Cayuse*	80	1968	1999
	Moana Wave†	*Kana Keoki*	168	1897	1987
			174	1973	2003
		Teritu	90	1863	1983
University of Miami	*CZRV 1 Cape Florida*		135	1981	2011
	Columbus Iselin	*Columbus Iselin*	170	1872	2002
	Calanus	*Calanus*	84	1970	2000
		Gillis	209	1964	1894
Duke University	*CZRV 2 Cape Hatteras*		118	1984	1984
		Eastward	135	1981	2011
University of Alaska	*Alpha Helix*		90	1991	1991
		Acona	133	1895	1995
University of Delaware	*Cape Henlopen*		120	1975	2005
University of Southern California	*Velero IV*	*Velero IV*	110	1948	1993
Johns Hopkins University	*Ridgely Warfield*	*Ridgely Warfield*	106	1897	1997
Calif. State University	*Cayuse*		80	1969	1999
University of Texas	*Longhorn*	*Longhorn*	80	1871	2001
University of Georgia	*Blue Fin*		95	1938	1958
		Kit Jones	72	1972	2002
Florida Institute Technology	*Tursiops*	*Tursiops*	95	1954	1984

*Based on a useful life of 30 years.
†Used exclusively by the Navy since 1978.

Present Trends and Activities

One bright spot in the academic fleet picture is that the Navy has started a program of midlife refits for the AGOR vessels, and the National Science Foundation has begun a similar refit program for ships it built. This would give these vessels an additional 15 years of service. The R.V. *Conrad*, the first AGOR to undergo midlife refit, is now in the shipyard. This ship barely escaped retirement this spring, when both the National Science Foundation and the Office of Naval Research critically questioned its future use and saw its retirement as a convenient solution to a projected $5 million deficit in the National Science Foundation's ship operating budget. Even with the refit, the AGOR's and *Atlantis II* will reach the end of their serviceable lives in the mid-1990's, and there are no plans underway to replace them.

It should be noted that it is not just the academic fleet that is shrinking. NOAA has recently laid up the *Oregon*, *Kelez*, *Surveyor*, and *Oceanographer* [*Mulcahy*, 1991], which represents a loss of 983 sea days per year.

The academic fleet, even in its reduced state, is underused. In 1980, there were 1620 days (based on 270 days/year/ship) available on the six ships longer than 200 ft, of which 1338 were used. For vessels in the 100- to 200-ft class, 2727 days out of a possible 3286 were used. Unused time requires the laying up of the larger ships for substantial periods of time. The projected use quotient is about the same for 1982, and there is no indication that the pattern will change in the near future. Curiously, during this same period, the leasing of privately owned research ships by the academic research community has increased. One of the reasons for leasing is to solve the logistical problems raised by the reduced fleet.

This decline in the use of ship time at sea is occurring in the face of a rapid growth in the production of doctoral scientists in all aspects of oceanography, and one must conclude that marine scientists are spending less time at sea. There are several reasons for this trend. One is the evolution of ocean science that is moving from an exploratory, data intensive phase toward more analysis of existing data and synthesis of global data sets in the framework of terrestrial and oceanic models. Another is the use of advanced data acquisition systems, such as multichannel seismic, multibeam sounders, moored stations, and modern hydrographic instruments that have greatly increased the data yield per day at sea; consequently, a day's data require more time ashore for analysis and interpretation. An additional reason is the increased activity by government agencies and commercial companies in oceanic sciences that has displaced some of the academic effort. This is especially true of marine geology and geophysics on the ocean margins, which is relevant to hydrocarbon assessment.

These reasons notwithstanding, it seems that the per capita decline in the requirement for sea time would be more than offset by the growth of the oceanographic community. The community is expected to nearly double between 1975 and 1985 [*Robinson et al.*, 1981].

The decreasing size of the U.S. research fleet is primarily governed by present economics. The advanced technologies required by some disciplines are more expensive to operate, causing the 'unit price' of marine studies to double and triple while NSF's budget has not. The operating costs of ships have risen sharply, well above the inflation rate, while the funds available for UNOLS ship operations have remained essentially constant over the past few years after inflation is taken into account (Table 2).

The sharp rise in fuel oil prices is one of the main factors in the rising costs of operating ships. The annual fuel bill for an AGOR size vessel is over $400,000, or about a quarter of the total annual cost, whereas in 1975 fuel accounts for only 12% of a vessel's operating costs. The rise in the price of bunker fuel was abrupt but lately has shown signs of becoming more stable. However, other costs ultimately depending on the energy cost are gradually catching up, and further increases in operating costs are expected. The daily rate for a ship of 210 ft is between $6,500 and $10,000. For the *Knorr* and *Melville* the rates are approaching $12,000 per day. The *Glomar Challenger* costs a whopping $33,000 per day to operate, and it is estimated that the *Glomar Explorer* will have a daily rate between $70,000 and $90,000 in 1984.

National Science Foundation Burden

The National Science Foundation supports about 70% of the costs of operating the UNOLS fleet. Ten years ago it supported only 55%, and the Office of Naval Research supplied most of the balance. The Office of Naval Research, however, has been regularly decreasing the percentage of its contribution to academic research fleet operations (Table 2). The Navy is providing about 10–12% of the $32.3 million dollar fleet budget in 1991 but is making a further contribution through the AGOR refit program and an oceanographic equipment updating program. Other sources, federal, state, and private, provide another $5 million (or 15%).

Over the past 7 years the National Science Foundation has provided the financial backstop for UNOLS through its 'Institutional Funding' policy for ship operations. By this policy, a proposal submitted to the National Science Foundation for a seagoing research project does not include ship costs in its budget; only an indication of the type of ship required and the number of days. If the proposal is successful in the peer-review process, the ship time is usually awarded to the institution operating the ship. There is no doubt this policy has made it easier to obtain funds for seagoing programs on larger ships through the National Science Foundation, compared with the Office of Naval Research, which requires that the ship time costs be included in the budgets. Other U.S. agencies, such as Department of Education, Bureau of Land Management, U.S. Geological Survey, etc., which occasionally use the UNOLS fleet, buy ship time as needed and accept little or no responsibility for the health or composition of the fleet.

The stated objective of the National Science Foundation's funding policy is to ensure that no important sea-going marine research is neglected because of a lack of ship time. If this objective were met, it would imply that the decrease in use of U.S. research vessels corresponds to a decrease in need. However, because NSF provides the lion's share of the funds for the fleet and the science that is done on it, things do not work out so simply. Over the long term it is the ocean science plans and policies that the NSF develops in close partnership with the ocean research community that determine the need for sea-going platforms. Thus the community should be concerned about two developing trends in NSF ocean science policy and planning: (1) the decline in the number of larger-scale multi-institutional programs during the 1980's and (2) the shifting balance among research disciplines, in particular the balance between the deep-sea drilling efforts and other areas of ocean science.

Large-Scale Ocean Science Programs

Since the end of the International Decade of Ocean Exploration (IDOE), the number of large multi-institutional, interdisciplinary programs has decreased substantially. The successor to IDOE, the Cooperative Ocean Research Exploration Studies (CORES) program, has been dropped by the National Science Foundation in favor of a general encouragement to the academic community to submit large, long-term programs. However, the long-term proposals compete directly with small science programs with much smaller budgets. The net result of this change is that there are few large programs in the works for the 1990's.

A National Academy of Sciences report [*Wooster et al.*, 1979], on the other hand, argued that the cooperative programs of the 1970's (MODE/POLYMODE, GEOSECS, and CLIMAP) had brought the marine sciences to a point where large cooperative efforts would truly pay off. For example, it is clear that the time is ripe for a program in the polar seas. A major result of the 1970's programs was a deepened appreciation for the importance of the polar regions on the world's climate, deep ocean circulation, and food and mineral resources. Yet, plans for the 1980's are relatively modest. To mount a polar program would require an ice-strengthened vessel that could operate safely in Arctic and Antarctic waters. There has been extensive planning for an Antarctic vessel, and a clear need has been defined; as of now, however, no action has been taken by the National Science Foundation.

Continental margins are another scientific target that seems due for a major program of exploration. Much insight into the evolution and processes in passive and active margins was gained in the past decade. Much of it came from deep-sea drilling, and drilling is the main tool planned for exploration in the 1990's. However, there is no organized program to use the remarkable capabilities of multichannel seismic sounding in a systematic way to study fundamental problems of the continental margins, as suggested in the National Academy of Science's report [*Bally et al.*, 1978]. Such a program would call for one or two ships in the academic fleet equipped with state-of-the-art bottom sounding equipment, the 'Dedicated Marine Geology and Geophysics Ship.' Some consideration is being given to developing such ships, but not within the framework of a major scientific program.

Deep-Sea Drilling

The deep-sea drilling programs, even though highly successful, have taken a toll on other more conventional areas of ocean science and, consequently, the research fleet. Drilling has made large demands on the funds available for ocean science. Over and above this is the enormous intellectual and managerial effort that it demands from the National Science Foundation and the academic oceanographic science community. NSF has customarily viewed the drilling program separately. For example, a drilling division was recently established separate from the ocean science division. The academic community, mostly following NSF's lead, is happy to view funds made available for drilling as 'new' money for research. Deep-sea drilling is an exceedingly important part of marine geoscience, but, fiscally and scientifically, drilling must be regarded within the context of the total U.S. program for ocean science.

Earlier, I indicated that the *Glomar Explorer* could well represent the only major addition to the U.S. seagoing capability in the 1990's. The Ocean Margins Drilling Program, the scientific framework within which the *Glomar Explorer* conversion is being developed, is one of the few large-scale ocean science programs for the 1990's. The program is now being restructured to permit broader international participation, a wider range of targets, and a lower overall cost. Commercial petroleum companies are participating in the program and are providing a major portion of the funding.

TABLE 2. Operating Funds for UNOLS Ships

	1973	1974	1975	1976	1977	1978	1979	1980	Proj. 1981
Agency									
National Science Foundation	11.6	12.5	13.4	13.8	15.0	15.8	16.5	18.2	23.3
Office of Naval Research	3.9	3.6	3.5	3.2	2.8	2.4	2.6	3.3	3.4
Other	1.5	2.1	2.8	3.0	4.3	4.8	4.2	3.8	5.0
TOTAL*	16.9	18.2	18.7	19.8	21.9	22.8	23.3	25.3	31.7

In millions of dollars.
*Average rate of increase 7.8%.

The success of the NSF-ocean sciences community partnership in generating monies for its research programs determines the fiscal outlook for the research fleet. In view of the cuts in the federal budget, the community must work with NSF in developing new sources of funds for basic marine research and finding greater efficiencies in operating its ships. Unless large and well-conceived programs that present a clear need for oceangoing capability are developed that can attract new monies within the agencies and gain support from the private sector, there will be no sizeable infusion of new funds to support the research fleet. Without new funds, the fleet will continue to shrink as all sober projections of present trends predict.

Acknowledgments

I owe much to Bob Dinsmore, Dennis Hayes, Michael Mullin, Charles Officer, and John Morrison for help with facts and figures.

References

Bally, A. W., et al., *Continental Margins: Geological and Geophysical Research Needs and Problems*, National Academy of Sciences, Washington, D.C., 1978.
Mulcahy, M., *R/V fleet shrinks in tight budget year*, *Sea Tech.* 22, 8–11, 1991.
Robinson, A. R., et al., *Doctoral Scientists in Oceanography*, National Academy of Sciences; Washington, D.C., 1981
Wooster, Warren S., et al., *The Continuing Quest: Large-Scale Ocean Science for the Future*, National Academy of Sciences, Washington, D.C., 1979.

Marcus G. Langseth is a senior research associate at Lamont-Doherty Geological Observatory, Palisades, New York.

Information Reports

AGU/ASLO Meeting

'Ocean Sciences: the AGU/ASLO Joint Meeting,' of the American Geophysical Union and the American Society of Limnology and Oceanography (ASLO), will bring together physical, biological, chemical, and geological oceanographers in an attempt to bring unity to ocean research. The meeting, slated for February 18–19, 1992, in San Antonio, Texas, will feature 18 special sessions.

'The AGU/ASLO meeting will provide a forum for all people working on the water column,' commented AGU Fellow Worth D. Nowlin, Jr., of Texas A&M University. Nowlin is one of the meeting's two convenors. The meeting should help to fill in the gap between physical and biological oceanographers, he added.

'Much of aquatic science is interdisciplinary, and many advances are expected from fruitful interactions across traditional disciplines,' said Richard W. Eppley, ASLO president and the meeting's other convenor. 'The joint meeting offers substantial opportunities for ASLO members to learn what is new and exciting on the physical side. The new ideas, insights, and aquaintances that develop can only strengthen our science,' he told *Eos*.

The latest addition to the roster of sessions is entitled SANDS (Shelf and Nearshore Dynamics of Sedimentation). The session will deal with recent research on the transport and accumulation of sediment in the continental shelf environment. A number of multi-disciplinary programs are currently underway, investigating shelf processes in different localities around the world, according to Chuck Nittrouer, session chairman. This will be an occasion to compare and contrast research results. The real strength of the joint AGU/ASLO meeting, he added, is that it will bring together physical oceanographers, benthic biologists, geochemists, and sedimentologists needed to examine fully sedimentary processes on shelves. For more information, contact Nittrouer (telephone: 919-737-3711).

A session on the 'Biology and Physics of Ice Edges' will deal with the special conditions that occur in the vicinity of the outer boundary of sea ice in the Arctic and Southern oceans. These conditions support a unique ecological system that may be the most diverse within the open polar ocean region. The ice-edge processes also determine the sharpness of the edge and the direction of change, leading to an expansion of the sea ice fields or to a retreat. Presentations on the physics of the ocean and sea ice and of the associated biology are encouraged. Following the presentations, there will be a discussion about effective interdisciplinary field approaches that would provide the required data base to develop a quantitative understanding of the sea ice edge. Session cochairmen are Arnold Gordon (telephone: 914-359-2900, ext. 325) and Vera Alexander (telephone: 907-479-7531).

The session entitled 'Overview of the Large Oceanographic Projects' aims to inform ASLO and AGU members of large aquatic programs and their impacts on research and opportunities. For additional information, contact Richard Eppley (telephone: 714-452-2338).

Papers presented at the session on 'Physical, Chemical, and Biological Processes in Large Lakes' will cover the mechanisms that control the fate and reservoir of pollutants in the Great Lakes. Except for Lake Superior, the Great Lakes have undergone accelerated eutrophication caused by phosphorous enrichment. Eutrophication, or the enrichment of a lake by dissolved nutrients, often is accompanied by seasonal oxygen deficiencies. Potentially toxic organic substances, such as PCBs, are found in the biota of all five lakes. These toxic organics are deposited in Lake Superior, the least polluted of the Great Lakes, from the atmosphere, according to session chairman Claire Schaiske. It is timely to consider these systems because of the present interest in the nation's water resources and the general lack of water in some parts of the country. In addition, knowledge is needed to implement and evaluate pollution-control strategies. For additional information, contact Schaiske (telephone: 313-764-2422).

Other sessions and their contacts and telephone numbers are listed below.

'Biology and Physics of Gulf Stream Rings,' Peter Wiebe (617-548-1400); 'Geological Effects of Ocean Circulation,' Charles Hollister (617-548-1400, ext. 2200); 'Anthropogenic Inputs to the Ocean: Diverse Points of View,' William Sackett (813-893-9131); 'Processes and Resources of the North Pacific Shelves,' John Goering (907-479-7895); 'Small Lake Limnology,' Georga Saundara (301-353-5548); 'Marine and Freshwater Bioturbation,' Peter McCall (216-368-2000); 'Ocean-River Interaction: Sedimentation and Chemistry,' Martha Scott (713-845-7211); 'Particle Fluxes in the Water Column and Benthic Boundary Layer,' Susumu Honjo (617-548-1400, ext. 2589); 'Relations Between Mesoscale Physical and Biological Processes,' John Steele (617-548-1400); 'Coastal Processes,' Worth D. Nowlin, Jr. (713-845-2947); 'Biological and Physical Measurement Techniques,' Peter Jumars (202-698-4590); 'Microscale Processes and Effects on Biota,' Ken Donman (604-658-3346) and Ann Gargett (604-656-8254); 'Relations Between Biology and Circulation in the Gulf of Mexico,' Tom Hopkins (516-282-2123); and 'Ocean Climate and Biological Productivity Connections,' Richard Barber (919-728-2111).

The abstract deadline is November 10. For additional information, see the call for papers in the June 23, 1981, issue of *Eos*.—*BTR*

News and Announcements

Sailing Ships for Research

Motor-assisted sailing ships for ocean research could perform as well as or better than many existing research vessels and could cut fuel consumption by 50–80%, according to a preliminary study by an ad hoc panel of the National Research Council's Ocean Sciences Board (OSB).

Rising fuel costs plague ship owners and operators. For example, 2 years ago the U.S. oceanographic fleet had a $6 million overrun in fuel costs. Furthermore, the price of marine diesel fuel skyrocketed from $3 per barrel in 1972 to about $38 per barrel in late 1980. Cutting these costs would be welcome if the savings were not made at the expense of additional crew, longer transit times, or less efficient scientific operations. A sailing ship with auxiliary motor propulsion is a promising prospect, according to the Ad Hoc Panel on the Use of Sailing Ships for Oceanography.

Substantial technological advances made in the past few decades make possible the construction of efficient sailing ships, according to the panel's report. 'One of the largest problems with sailing ships in the past has been the uncertainty of arrival time at the next port or station. However, the combined use of sail and engines, the knowledge of the winds and seas ahead based on satellite data and modern forecasts, and the help of computers to lay a course and steer it, will greatly reduce the uncertainties.' Materials now available that would increase durability and reduce maintenance include aluminum for cabins and masts, polyester

A tentative design for a motor-assisted sailing ship for oceanography research, sketched by Robert Parrett. Rising from the proposed 75-m-long ship are three 50-m masts. The widest point of the vessel measures approximately 15 m. The ship could carry a crew of 19, 3 cadets, and a scientific team of 19. The onboard electric plant consists of three 400-HP diesel engines, a 400-HP main prop, and a 200-HP bow thruster. (Photo courtesy of Willard Bascom).

fabrics for sails, Kevlar polyaramid fiber for lines, and improved paints.

A ship incorporating these features would have several advantages over modern research vessels that are solely engine powered, according to the panel. Vibrations and noise generated by engines would be reduced, and the sails would limit the ship's rolling. Fuel consumption changes the fuel load and, with it, the ship's stability; by reducing the rate of fuel consumption, sails will slow the change in stability.

'The largest problem to be overcome [with the motor-sailer] may be the state of mind of some scientists or administrators who know little about large sailing ships and may react negatively before investigating the possibilities,' states the panel report. Other problems include the potential interference with deck operations by the sailing ship's rigging and the possibility that the mast height would prevent the ship from entering harbors with low bridge clearances.

Nevertheless, the panel, chaired by Willard Bascom of the Coastal Water Research Project, recommended that OSB 'take the lead in proposing further investigation of the possibilities for using sailing ships for oceanographic research.' Further study 'would better define requirements, relation to the rest of the oceanographic fleet, size, hull form, sail plan, automation possibilities, and fuel savings on various voyages, and make preliminary capital and operating cost estimates.'

To give OSB a head start, the panel offered a design sketch of a motor-assisted sailing ship (see diagram) and some tentative specifications.—*BTR*

Deep Sea Cores Available

Scientists aboard the *Glomar Challenger* collected a 235-m core of marine sediment specifically for geochemical study. This core, obtained with the hydraulic piston corer from site 532 (leg 75) in the South Atlantic, was frozen immediately upon its retrieval to preserve its organic geochemical properties. Samples from this core are now available to researchers.

Site 532 is a reoccupation of deep-sea drilling (DSDP) site 362 of leg 40. The organic carbon content in this bioturbated core ranges between 1 and 6% and appears to fluctuate markedly on a time scale of 20,000–50,000 years. The lowest values occur in deeper sediments, and they generally are higher in younger sediments, reflecting an intensification of upwelling conditions at this location. An organic carbon maximum in upper Pliocene sediments records stronger upwelling conditions during that time.

The shipboard party obtained two other cores at site 532 that are the subjects of numerous paleontological, sedimentological, geochemical, and geophysical studies. The information from these current investigations combined with earlier studies from DSDP leg 40 and from the nearby Walvis Bay–Namibian shelf area provide an interpretation background not often available to geochemists studying core materials.

Investigators wishing to receive frozen core samples should send a brief (300 word) description of the proposed study and their sample requirements to Bernd R. T. Simoneit, Chairman, Organic Geochemistry Advisory Panel, School of Oceanography, Oregon State University, Corvallis, OR 97331.

Note From the Associate Editor

• It has been mentioned to me that a directory of the numerous active 'newsletters' in the marine sciences would be of value. To this end, I would like to request the various editors or compilers of newsletters to send me the name, objective, and contact for their newsletter. Thank you.

• David Ross' name and affiliation were given at the end of his article 'Marine Science and the Law of the Sea,' which appeared in the first issue of The Oceanography Report (*Eos, 62*, September 1, p. 650). Just in case some readers may have missed the author's name, I would like to thank David Ross directly for his excellent and timely article. He clearly points out that all marine sciences have a stake in the Law of the Sea. David Ross is a senior scientist in the Geology and Geophysics Department of the Woods Hole Oceanographic Institution. He is also the Sea Grant Coordinator and Director of the Marine Policy and Ocean Management Program at that institution. As a member of the Ocean Policy Committee of the National Academy of Sciences and a member and now chairman of its Freedom of Ocean Science Task Group (FOSTG), he has been able to follow closely the Law of the Sea negotiations for the past 4 years. He is also a member of the State Department's Advisory Committee on the Law of the Sea.—*ALG*

Meetings

Curators of Marine Samples to Meet

Curators of marine samples will meet on Sunday, November 1, immediately preceding the Geological Society of America meeting (November 2–5) in Cincinnati. The agenda includes discussion and evaluation of the 'Curator's Format' for reporting core and sediment data with the National Geophysical and Solar-Terrestrial Data Center (NGSDC). An attempt also will be made to formulate a similar NGSDC format for reporting dredge sample data using an acceptable classification schema for dredged rocks. Other items on the agenda include funding problems, an update on the Long Core Facility, and brief presentations on new repository facilities, such as the University of Rhode Island and the Woods Hole Oceanographic Institution.

The curator's group was organized during a 1977 meeting of curators and curatorial representatives from all major repositories of marine samples in this country. Representatives from NGSDC also participated because the initial goal was to establish a uniform scheme for reporting station and sediment data from gravity cores, grab samples, piston cores, box cores, etc. This was done, and is now referred to as the 'Curator's Format.' The cooperation has continued and now includes representatives from Canada, England, and France. This meeting, from 1 p.m. to about 6 p.m. in Cabana A and B of Stouffer's Hotel, will be the fourth one, and participation is welcome by anyone interested in marine science, data handling, sampling equipment design, etc.

For more information please contact Floyd W. McCoy or Mrs. Rusty Lotti, Lamont-Doherty Geological Observatory, Palisades, NY 10964 (914-359-2900).

Scientific Ocean Drilling

'Future Scientific Ocean Drilling Programs: The Problems, Objectives, and Plans,' is the title for the Conference on Scientific Ocean Drilling (COSOD), scheduled for November 16–18 at the University of Texas at Austin. Sponsored by the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES) and convened by the COSOD Steering Committee, the meeting is open to the general scientific community; there is no registration fee.

On the agenda for the first 2 days of the conference are reports and workshop discussions on the origin and evolution of oceanic crust; on the origin and evolution of marine sedimentary sequences; on the tectonic evolution of continental margins and oceanic crust; and on the causes of long-term changes in the atmosphere, oceans, cryosphere, biosphere, and magnetic field. The third day will feature general discussion on the problems, objectives, and plans of present and future scientific ocean drilling programs.

Hotel and travel arrangements can be made through Mercury Travel, 1333 New Hampshire Ave., N.W., Washington, D.C. 20036 (telephone: 202-296-7882).

If you plan to attend, send your name, affiliation, address, and areas of interest to Peter Belknap, COSOD Secretary, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882.

Conference on Scientific Ocean Drilling (COSOD)
Sponsored by JOIDES

ORGANIZATION AND COORDINATION OF PLANS FOR FUTURE SCIENTIFIC OCEAN DRILLING PROGRAMS

November 16–18, 1981, Austin, Texas
Convened by: COSOD Steering Committee, R. L. Larson, Chairman

Sessions Planned:

November 16, 17
Reports and workshop discussions on the relation of the following topics to ocean drilling:

1. Origin and Evolution of Oceanic Crust
2. Origin and Evolution of Marine Sedimentary Sequences
3. Tectonic Evolution of Continental Margins and Oceanic Crust
4. Causes of Long-Term Changes in the Atmosphere, Oceans, Cryosphere, Biosphere, and Magnetic Field
5. Tools, Techniques, and Associated Studies

November 18
General Discussion on Coordination of Existing and Planned Scientific Ocean Drilling Programs

The meeting will be open to the general scientific community, and there is no registration fee. The conference will begin at 9:00 AM on November 16 at the Joe C. Thompson Conference Center, Room 3-102, on the University of Texas campus. For hotel reservations and other travel arrangements, please contact Mercury Travel, 1333 New Hampshire Ave., N.W., Washington D.C. 20036, phone (202) 296-7882.

(cont. from page 689)

can only be effected at 1–2 kb pressure relevant to this discussion at temperatures below 250° C.' In fact, temperatures of over 370° C have been encountered in several geothermal areas. In discussing some of the effects of geothermal exploitation he notes 'at The Geysers a blow-out blew the top off a hill' (not true). Also in drilling at The Geysers, 'more bits may be lost due to the high state of fracturation' (p. 67). There are numerous cases where decimal points have been left out or misplaced, which leads to large errors of fact. There is an extensive discussion in chapter 5 on artificial stimulation of geothermal systems, and explosive stimulation is treated as if it were a routine practice. In fact I have not heard anyone seriously proposing such stimulation techniques. Given the quality of the book and the information content, the price is probably one of the most outrageous overcharges I have come across in some time. Several times more information per dollar can be obtained by purchasing the U.N. Symposium volumes or the GRC Transactions or by joining a geothermal organization. The author, editors, and publisher of this book ought to be embarrassed.

David D. Blackwell is with the Department of Geological Sciences, Southern Methodist University, Dallas, Texas.

Circulation Models of Lakes and Inland Seas

T. J. Simons, Government of Canada Fisheries and Oceans, Ottawa, viii + 146 pp., 1980, $14.40.

Reviewed by Malcolm Bowman

This book is a sophisticated review of hydrodynamic theory with applications to large-scale circulations in lakes and inland seas. It assumes the reader has a working knowledge of geophysical fluid dynamics. As such, this is not a text for someone wanting to get started in numerical modeling, either in understanding the basic theory or deciding what type of model to develop or apply to a given problem. This is not intended as a criticism of this particular text, but the science of hydrodynamic modeling, both analytical and numerical, is very complicated and is not readily accessible to limnologists and oceanographers in general.

Chapters 1 and 2 review, and sensibly do not attempt to derive, the fundamental equations of mass, momentum, and energy balances both for vertically integrated and layered formulations of these equations.

Chapter 3 summarizes known analytical solutions to vertical current variations, principally steady state, time dependent and stratified Ekman flows, and the normal modes of a stratified basin.

Numerical solution techniques (principally the finite difference method) are discussed in chapter 4. This is more of a historical review of the great diversity of numerical techniques that have evolved rather than a mathematical analysis. The reader will have to delve further into the pertinent literature to get help in deriving suitable algorithms for a particular problem.

Chapter 5 and 6 summarize current understanding of steady state and time-dependent circulations in homogeneous basins, while chapter 7 discusses stratified flows. Most of the examples of modeled and observed flows are for Lake Ontario, which presumably reflects the proximity of the Canadian National Water Research Institute to this inland sea. Contaminant transport and mixing by advection and diffusion and its coupling to the hydrodynamics are not discussed in any detail. Tidal hydrodynamics are by nature outside the scope of the book.

I am sorry that the author did not provide a summary chapter in which he might have shared his candid views on the inadequacies of present modeling efforts. This might have enabled those of us who are more interested in applying rather than developing models to become more aware of their limitations and sometimes downright fictitious predictions. Strangely, the book lacks a subject index.

This monograph will be of great benefit as a reference text to the advanced modeler of large-scale circulations in inland seas and a guiding light to those of us struggling to do a credible job of modeling the complexities and overwhelming variability of the marine environment.

Malcolm Bowman is with the Marine Sciences Research Center, State University of New York, Stony Brook, New York.

Classified

POSITIONS AVAILABLE

Faculty Positions: The University of Iowa. The Department of Physics and Astronomy anticipates one or two openings for tenure-track faculty in August 1982. One or more visiting professorships, at any rank, are also expected to be available. Preference will be given to candidates with research activity in the following experimental and theoretical areas: astronomy, astrophysics, atomic physics, condensed matter physics, elementary particle physics, nuclear physics, plasma physics, and space physics. The positions involve undergraduate and graduate teaching, guidance of research students, and personal research. Interested persons should send a résumé, a statement of research interests, and the names of three professional references to Search Committee, Department of Physics and Astronomy, The University of Iowa, Iowa City, IA 52242.

The University of Iowa is an equal opportunity/affirmative action employer.

Director: Geodetic Survey, NOAA. The National Oceanic and Atmospheric Administration (NOAA) announces a Senior Executive Service Vacancy for the position of Director, Geodetic Research and Development Laboratory (GRDL) in the National Geodetic Survey, a component of the National Ocean Survey. The duty location is Rockville, Maryland. The salary range is $47,889–$50,112.50 per annum. Duties include providing technical and administrative supervision over employees and activities of GRDL; advising officials on the state of scientific knowledge in geodesy and making recommendations for research and development; exercising scientific and technical knowledge of contributing publications to professional journals and making presentations at national and international meetings; and advising and consulting scientists and executives in improvement of geodesy and related fields. Experience in management of scientific programs, geodesy, and solid earth sciences is required. Apply to: NOAA/NOS-6001 Executive Boulevard, Rockville, Maryland 20852. Attn: MB/PER15:TR

NOAA is an equal opportunity employer.

Geophysicist/Geologist: The University of Texas at Austin, Institute for Geophysics. Four research scientist positions are now available at the University of Texas Institute for Geophysics in the fields of marine geophysics, tectonics, seismic stratigraphy, seismic reflection techniques and data processing, ocean bottom seismometer (OBS) and other seismographic instrument design and development, earthquake seismology, and lunar and planetary seismology.

The Institute maintains a modern dockside facility at Galveston, Texas (Galveston Marine Geophysics Laboratory), where a new marine building will be built next year. There is also a component of the Institute based in Austin. The Institute has a modern computer facility for processing and analyzing geophysical data and will be obtaining a new VAX interactive computer system early next year. The Institute maintains two research vessels, the R/V IDA GREEN and the R/V FRED H. MOORE, which have capabilities for conducting marine geophysical surveys including the collection of magnetics, multifold seismic reflection data (48-channel), sonobuoy data, and OBS refraction and earthquake data. This two-ship capability offers the exciting opportunity to conduct two-ship seismic experiments. In addition, the Institute operates extensive seismographic networks in several Central American and Caribbean countries. The Institute maintains close ties with the staff and facilities of the Department of Geological Sciences, which include modern radiometric, isotope, and paleomagnetic laboratories.

A Ph.D. degree is required, preferable in Geology or Geophysics. Salaries are negotiable depending upon experience and qualifications. The person must have the ability and desire to work on group projects, conceive and initiate new projects, collect and reduce data, and publish the results. If you are interested in this excellent opportunity to pursue a challenging career in the forefront of geophysical research in an academic setting, please send your qualifications and references to:

Director
The University of Texas
Institute for Geophysics
Galveston Marine Geophysics Laboratory,
700 The Strand
Galveston, Texas 77550.

The University of Texas is an equal opportunity/affirmative action employer.

Economic Geologist, University of Iowa. The Department of Geology invites applications for a tenure track position in economic geology. Appointment will be at the assistant professor level, beginning in August 1982. Applicants should be field oriented with primary research interests in the chemistry of ore deposits. Experience in industry and with modern techniques in geochemistry, computers, and applied mathematics would also be desirable. Candidates should aim to develop a strong research program, taking advantage of companion programs here in mineralogy and petrology, structural geology, geophysics, and remote sensing. Teaching duties will include introductory and advanced courses which will provide students with broad training in economic geology. PhD degree is required at time of appointment.

The Department shares its Geology building with the State Geological Survey. Equipment includes X-ray diffractometers, chemical lab, A.A., automated microprobe, S.E.M., microscopes, cathodoluminescope, geophysics and remote sensing facilities, and in-house computer terminals. The Department has 120 undergrad majors and 60 graduate students. The University, a Big Ten school centrally located in the Midwest, is situated on the scenic Iowa River in a community of 60,000 with a high quality of life.

Applications desired by end of December 1981. Salary minimum of $25,000.

To apply, send complete biography and names of three references to Robert S. Carmichael, Department of Geology, University of Iowa, Iowa City, Iowa 52242.

The University of Iowa is an equal opportunity/affirmative action employer.

Atmospheric Scientist/Oceanographer Position: The Joint Institute for the Study of the Atmosphere and Ocean, University of Washington. Atmospheric scientist/oceanographer needed to undertake analysis of interannual and interdecadal climate-related fluctuations in the ocean and atmosphere as revealed by marine surface observations from ships of opportunity and island stations.

Applicants should show evidence of published work on related topics and be adept at eliciting dynamical properties from the analysis of large data sets.

The position is offered through the Joint Institute for the Study of the Atmosphere and Ocean, a cooperative research institute between the University of Washington and the National Oceanic and Atmospheric Administration. The work will be carried out in conjunction with scientists at the University and at the NOAA Pacific Marine Environmental Laboratory, which is housed on the University campus.

Appointment is for one year, with a possibility of renewal for subsequent years up to a three-year term. Salary is negotiable, depending on qualifications and experience.

To apply or request further information, write to Director, J.I.S.A.O., Department of Atmospheric Sciences, AK-40, University of Washington, Seattle, WA 98195 U.S.A. Applications should include resumé, bibliography, and two letters of recommendation. Closing date November 15, 1981.

An equal opportunity/affirmative action employer.

Engineering Geologist/Geophysicist. The Department of Geological Sciences, University of Saskatchewan, has a vacant tenurable position in engineering geology/geophysics. Applicants should be qualified to teach undergraduate and graduate courses and to conduct research in engineering geology. A background in structural geology may be appropriate. Well-equipped facilities are available for research in rock mechanics, fluid flow through porous media, acoustic, and electrical properties of rocks, and permafrost. Good opportunities exist for joint research with qualifications and experience. Send applications, detailed personal resume including the names of at least three referees, and other supporting data to Dr. W.O.E. Caldwell, Head, Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan, S7N 0W0.

Please note: until November 15, 1981 consideration will be given only to applicants who are Canadians or landed immigrants, after that date all applications will be considered.

Yale University/Department of Geology and Geophysics. Applications are solicited for a faculty position in solid earth geophysics to begin in the academic year 1982–83. Areas of interest to the Department include seismology, exploration geophysics, mechanical and physical properties of rocks and minerals, geomagnetism, and tectonophysics.

Yale University is an equal opportunity/affirmative action employer and encourages women and members of minority groups to compete for this position.

Curriculum vites, publications and the names of three or more referees should be sent by 31 December 1981 to Robert B. Gordon, Chairman, Department of Geology and Geophysics, P.O. Box 6666, New Haven, CT 06511.

University of Maryland/Faculty Position. The University of Maryland invites applications from highly qualified scientists for a tenure track faculty position at the assistant or associate professor level in the Department of Meteorology. Candidates must have a Ph.D. in meteorology, physics, engineering or chemistry and have an area of specialization that will enable them to lead a research program in environmental physics and air pollution. The research activity of the candidate should complement the meteorological research of the Department and continue the strong interaction in the physical sciences across departmental lines. Duties will include teaching senior/graduate courses related to environmental physics and air pollution and developing an active research program. Salary will be commensurate with qualifications and experience. All applicants should send curriculum vitae, a brief statement of research interests and names, addresses and telephone numbers of three professional references to: Professor Ferdinand Baer, Chairman, Department of Meteorology, University of Maryland, College Park, MD 20742. Closing date for applications is 1 December 1981.

The University of Maryland is an equal opportunity/affirmative action employer.

AIR FORCE GEOPHYSICS LABORATORY

CHIEF SCIENTIST

Air Force Geophysics Laboratory invites applications for the position of chief scientist located at Hanscom Air Force Base, Massachusetts. The Laboratory is responsible for Air Force research and development in atmospheric physics, solar-terrestrial interactions, ionospheric and stratospheric phenomena, aeronomy, meteorology and weather phenomena, geodesy, gravimetry, seismology and related technologies.

The chief scientist serves as an interface between the scientific researchers of the Laboratory and the outside professional technical community. He recommends promising areas for new research and attempts to enhance the professional stature and reputation of the organization and its scientific output of publications and technical reports.

A candidate should have a record of distinguished achievement in geophysics or atmospheric physics as a research scientist. This position is Air Force Senior Executive Service with a salary range of $52,247 to $57,673, subject to current $50,112 ceiling.

For an application package, call collect:

Mr. Robert Ellerin, (617) 861-2896
or
Mr. Joe Solivan (617) 861-4581.

To be considered, applications must be returned by 30 October 1981.

Equal Employment Opportunity Employer.

Petrologist: Northern Illinois University. Applications are invited for a tenure track position in igneous or metamorphic petrology at the assistant or associate professor level beginning either January, 1982 or August, 1982. A Ph.D. degree is required and post-doctoral research experience is preferred. The successful candidate will be expected to pursue an active research program, teach at the undergraduate and graduate level, and direct Masters and Ph.D. graduate research work. Facilities housed within the Department of Geology include a fully automated electron microprobe, SEM, solid-source and gas-source mass spectrometers, AA, XRD, and XRF. To receive full consideration, please send resume, statement of research interests, and the names of three references, by November 1, 1981, to Jonathan H. Berg, Search Committee Chairman, Department of Geology, Northern Illinois University, DeKalb, Illinois, 60115.

An equal opportunity/affirmative action employer.

Virginia Polytechnic Institute and State University: Senior Research Associate. Interesting and abundant research and publishing opportunities, including new University-owned MOS-10 VIBROSEIS system, VAX 11/780 computer. Must have experience in theory and application of reflection seismology, and be interested in the application of reflection seismology to the solution of geologic problems.

Send resumes to: Dr. D. R. Wones, Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0796.

The University is an equal opportunity/affirmative action employer.

Seismologist. Applications are invited for a postgraduate research position in seismology at the Scripps Institution of Oceanography. Applicants specializing in all areas of seismology will be considered, although preference will be given to recent graduates interested in seismic wave propagation, particularly as applied to the oceanic environment and digital signal processing. The position has a duration of one year, with the possibility of extension to two years, and an annual stipend of $18,960. Please send resume and three references to either Dr. Thomas H. Jordan or Dr. John Orcutt, A-015, Geological Research Division, Scripps Institution of Oceanography, La Jolla, CA 92093, prior to 1 December 1981.

Scripps Institution of Oceanography, University of California, San Diego is an affirmative action/equal opportunity employer.

Faculty Position: Environmental Engineering. Beginning January or September 1982. The position requires undergraduate and graduate teaching and sponsored research activities in the areas of water quality control and water resources. An earned doctorate is required and at least one degree in civil engineering is preferred. Rank will be at the assistant professor level and salary will depend upon qualifications. Apply to: Dr. Lester A. Hoel, Chairman, Department of Civil Engineering, University of Virginia, Charlottesville, Virginia 22901.

An affirmative action/equal opportunity employer.

City University of New York, (Brooklyn College): Faculty Positions. The Department of Geology anticipates filling several tenure track positions at Full Professor level. (Salary range up to $43,400). Highly qualified individuals will be considered for distinguished appointments at an additional $5,000.

While candidates who have distinguished themselves in any field are welcome to contact us, we are particularly interested in openings in energy resources (coal petroleum), exploration geophysics, environmental geology or hydrogeology, coastal sedimentology, economic geology.

Successful applicants will be required to institute an active research program, supervise Master's and Ph.D. theses. Nominations and applications with current vitae should be sent to: Dr. S. Bhattacharji, Chairman, Dept. of Geology, Brooklyn College of City University of New York, Brooklyn, New York 11210. Positions open until filled.

Brooklyn College, CUNY, is an affirmative action/equal opportunity employer.

Purdue University. The Department of Geosciences invites applications for a faculty position, starting January or July 1982, in the broad field of mineralogy-petrology-geochemistry. A Ph.D. is required and preference may be given to scientists with an established record of research. The Department has an automated electron microprobe, mass spectrometer and laboratory for stable isotope studies, full range of high temperature and high pressure equipment, including furnaces for controlled fO_2 experiments, as well as X-ray equipment. The successful applicant will be expected to participate in both the undergraduate teaching and graduate studies programs, as well as actively engage in research. Rank and salary are open but will be commensurate with qualifications.

Purdue University is a land grant, state supported institution committed to academic excellence, and is an equal opportunity/equal access employer. For further information please contact Dr. Henry O. A. Meyer, Dept. of Geosciences, Purdue University, West Lafayette, IN 47907 (Tel. 317-494-3271).

Closing date for applications is November 10, 1981.

Faculty Positions. Arizona State University, Department of Geology. Applications are invited for two tenure-track faculty positions, one at the assistant professor level and one at the associate level, beginning in August of 1982. One of these positions requires a candidate with interests in applying modern solid state science to geological phenomena. The selected candidate should develop an active research program and may use the extensive opportunities offered by the Facility for High Resolution Electron Microscopy at ASU. Teaching duties will include undergraduate mineralogy. Candidates for the other position should complement and extend existing strengths in the department. Possible areas include low temperature geochemistry, heavy isotope geochemistry, solid earth geophysics, tectonophysics, and related fields. The ability to use modern techniques in both field and laboratory studies and to integrate diverse approaches is highly desirable. Please send a detailed statement of research and teaching interests and a resume

with names of four references to David Krinsley, Department of Geology, Arizona State University, Tempe, AZ 85287, by January 15, 1982.

Arizona State University is an equal opportunity/affirmative action employer.

EARTH SCIENCES

The Lamont-Doherty Geological Observatory of Columbia University invites scientists interested in any field of the earth sciences to apply for the following fellowships: two postdoctoral fellowships, each awarded for a period of one year (extendable to two years in special instances) beginning in September 1982 with a stipend of $22,500 per annum. Completed applications are to be returned by January 15, 1982. Application forms may be obtained by writing to the Director, Lamont-Doherty Geological Observatory, Palisades, New York 10964. Award announcements will be made February 26, 1982 or shortly thereafter.

The Observatory also welcomes applications from candidates for postdoctoral research associate positions in this discipline.

Structural Geology/University of Illinois at Champaign-Urbana. (Search reopened) The Geology Department is seeking a structural geologist for a tenure-track (assistant professor) faculty position. A Ph.D. is required. Salary open. The successful candidate will be expected to teach advanced undergraduate and graduate courses in structural geology and establish a research program. For equal consideration, applications, including the names of three referees, should be sent by February 1, 1982 to Dr. D. E. Anderson, Department of Geology, University of Illinois, 245 Natural History Building, 1301 West Green Street, Urbana, IL 61801–2999, (217) 333-3713.

Position to be filled by September 15, 1982.

The University of Illinois is an affirmative action/equal opportunity employer.

Groundwater Hydrologist. The Minnesota Department of Natural Resources, Division of Waters has a vacancy at the Principal Hydrologist level for an experienced groundwater hydrologist to provide leadership for a program of ground water studies and monitoring to support State Water allocation decisions and to provide quantitative assessments for planning and management purposes. Address inquiries and requests for application forms to: Sarah P. Tufford, DNR-Division of Waters, Third Floor Space Center Building, 444 Lafayette Road, St. Paul, Minnesota, 55101. Present salary range $23,323 to $31,132 annually, subject to revision in the near future.

Oceanographer or Meteorologist. The Office of Research and Development, National Oceanic and Atmospheric Administration (NOAA), has announced the vacancy of oceanographer or Meteorologist located in the Office of Programs and International Activities, Program Coordination Division. The Division is looking for an oceanographer or meteorologist to be responsible for providing technical guidance in planning, coordinating, evaluating and recommending proposed research projects and programs in oceanography or meteorology (and related fields of interest to NOAA). QUALIFICATIONS FOR OCEANOGRAPHER: Candidates must possess a Bachelor's degree or equivalent in oceanography (or related discipline) which included: (1) 24 semester hours in oceanography or related disciplines; *plus* (2) 20 semester hours in any combination of oceanography, physics, geophysics, chemistry, math, meteorology and engineering. Must also have three years of professional experience in or directly related to oceanography. QUALIFICATIONS FOR METEOROLOGIST: Candidates must possess a Bachelor's degree or equivalent in meteorology which included 20 semester hours in meteorology. Must also have three years of professional experience in or directly related to meteorology. SALARY: Entry salary will range from $23,566 to $33,586 per annum. APPLICATION: Standard Form 171 applications (Personal Qualifications Statement) must be received no later than October 20, 1981 by Mrs. S. Ctsor, Office of Personnel (MB/PER11), NOAA, 6001 Executive Boulevard, Rockville, Maryland, 20852.

The Department of Commerce, National Oceanic and Atmospheric Administration is an equal opportunity employer.

Sentrell Postdoctoral Fellowship. The California Institute of Technology invites applications for the Sentrell Postdoctoral Fellowship Program in Earthquake Seismology at the Seismological Laboratory. Appointments will be made for one year with the possibility of a second year renewal. The 1981–82 stipend is $22,900 plus travel expenses. The program is limited to United States and Israeli citizens. Interested persons are asked to contact: Dr. Barclay Kamb, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91125.

An equal opportunity/affirmative action employer.

Instrumental Analyst/Staff Research Associate III. Job # 81-D8-23. Oversee computer-automated wave-length dispersive XRF spectrometer. Minimum qualifications: two years analytical experience or equivalent academic background, preferably but not necessarily with XRFC or NOVA computer. Duties include: maintenance and repair of equipment; software development in FORTRAN for on-line minicomputer; participation in design and execution of strategies for analyzing trace metals in geological materials; and instruction of users. After first year, opportunity exists for personal research as time permits. Applicants should list equipment and applications with which they're experienced, and responsibilities therewith. Salary $1755/month.

Apply to Personnel Office, University of California Santa Cruz, 1156 High Street, Santa Cruz, Ca. 95064 no later than November 1, 1981.

The Caswell Silver Distinguished Professorship in Geology

THE UNIVERSITY OF NEW MEXICO

The Department of Geology of the University of New Mexico is pleased to invite nominations or applications for the Caswell Silver Distinguished Professorship in Geology. This endowed professorship shall be awarded for periods of up to two years to earth scientists of distinguished accomplishment and international reputation. The professorship may be held by scientists of all specialties of the earth sciences in the broadest sense, and the major criterion for selection is that the individual be an active, productive leader in his or her field of research. The recipient must carry out a vigorous research program while in residence at UNM. The recipient is expected to interact with the faculty and students of the Department and to provide one or more seminars, in an advanced topic of his/her choice, during each academic year. The Foundation will provide unusually advantageous remuneration commensurate with the distinguished nature of the appointment. In addition, a generous allocation for travel and operating expenses (to include secretarial support, analytical services in department laboratories, use of field vehicles, and preparation of manuscripts) will be provided.

Applications or nominations should include a detailed resume and brief statement of major research accomplishments. Applications or nominations should be forwarded to:

Rodney C. Ewing, Chairman
Department of Geology
University of New Mexico
Albuquerque, New Mexico 87131

The deadline for applications is January 1, 1982.
The Caswell Silver Foundation is an equal opportunity employer.

Assistant Professor/Department of Geology, University of Vermont. The Geology Department at the University of Vermont is recruiting for a tenure track position at the assistant professor level to begin September 1982. Field of specialization should complement existing faculty expertise in petrology, structure and regional geology. Applications are solicited in, but not restricted to, geophysics, igneous petrology/geochronology, hydrology/Pleistocene or economic geology. The successful candidate will be expected to develop a research program involving both graduate students (M.S.) and advanced undergraduates. Applications will be accepted until December 1981.

Candidates should send resume and arrange for three letters of reference to be sent to:

Dr. John C. Drake
Acting Chairman
Department of Geology
University of Vermont
Burlington, VT 05405

The University of Vermont is an equal opportunity/affirmative action employer.

Quaternary Sedimentation and Tectonics or Geophysics. The Geology Department at Miami University invites applicants for a position in either the field of Quaternary sedimentation (including glacial deposits) and tectonics or the field of geophysics. This position is to be filled at the Assistant Professor level beginning in August, 1982. The successful candidate will teach both undergraduate and graduate courses, must possess the Ph.D. degree and have documented ongoing research to be considered for the tenure track position.

Quaternary Sedimentation and *Tectonics*. Ideally applicants should have research and teaching interests in: (1) basin development and recent tectonics; (2) Quaternary sediment transport and depositional processes including till deposition; and (3) geomorphology.

Geophysics. Applicants should have research and teaching interests in: (1) relations between crustal structure and basin and continental margin evolution; or (2) general geophysics to include areas from among seismology, geomagnetism, gravity, electrical or heat-flow studies.

Visiting Assistant Professorship in Geology. The Department also invites applicants for a visiting assistant professor position beginning in August 1982. The position is of 1 to 3 year duration and is nontenure track. The successful candidate must have the Ph.D. and will be responsible for teaching introductory-level courses as well as teaching and study in the person's area of research interest. This area is unspecified. The successful applicant will be chosen on the basis of qualifications and ability to interact with researchers currently on the staff.

Applicants should send a resumé, transcripts, three (3) letters of reference and an outline of teaching and research interests to: Dr. A. Dwight Baldwin, Jr., Chair, Geology Department, Miami University, Oxford, Ohio 45056.

An equal opportunity/affirmative action employer.

Visitor Appointments NCAR. Visitor Appointments at the High Altitude Observatory are available for new and established Ph.D.'s for up to one year periods to carry out research in solar physics, solar-terrestrial physics, and related subjects. Applicants should provide a curriculum vitae including education, work experience, publications, the names of three scientists familiar with their work, and a statement of their research plans. Applications must be received by 15 January 1982, and they should be sent to: Visitor Committee, High Altitude Observatory, National Center for Atmospheric Research (NCAR), P.O. Box 3000, Boulder, Colorado 80307. NCAR is an equal opportunity/affirmative action employer.

Geophysical Fluid Dynamicist/Physical Oceanographer. Applications are solicited for a junior faculty position in ocean physics or dynamics to begin in the academic year 1982–83. Areas of interest to the Department include analytical, numerical and laboratory modeling of physical processes and phenomena in the sea.

Yale University is an equal opportunity/affirmative action employer and encourages women and members of minority groups to compete for this position.

Curriculum vitae, publications, and the names of three or more referees should be sent by 31 December 1981 to: Robert B. Gordon, Chairman, Department of Geology and Geophysics, P.O. Box 6666, New Haven, CT 06511.

University of Tennessee, Knoxville/Faculty Positions. The Department of Geological Sciences (Main Campus of the UT System) invites applications for two or three tenure track teaching/research positions effective September 1, 1982.

The appointments will be at the assistant or associate professor level in:

1. Sedimentology or Low-Temperature Geochemistry
2. Metamorphic Petrology or Mineralogy.

The Ph.D. is required. Duties will include pursuit of an active research program as well as teaching and advising at graduate and undergraduate levels. Preference will be given those with documented research capabilities. Applicants will be interviewed at the Cincinnati G.S.A. meeting. Send resume (including transcripts) and names of 3 referees to: Thomas W. Broadhead, Search Committee, Department of Geological Sciences, University of Tennessee, Knoxville, TN 37916. Application deadline, January 15, 1982.

UTK is an EEO/Title IX/Section 504 employer.

Environmental/Surface Geologist. The University of Pittsburgh at Bradford is seeking a person with a broad range of interests to fill a tenure track position in its Earth and Environmental Science Program beginning in January (preferred) or September 1982. This program is a geology-based environmental program which started in 1980 and now has twenty-five majors.

The successful applicant will be responsible for the continued growth and evolution of the program.

He or she should have a desire to undertake locally oriented research (with the aid of the undergraduates) and be able to teach physical geology and all or most of the following on a rotating basis: hydrology, geomorphology, soil science (or soil geology), and environmental geology. Rank and salary are open.

A Ph.D. is preferred but applicants with a Master's degree and significant work experience will be considered. Engineering background helpful.

Bradford is located in the Allegheny Mountains of northwestern Pennsylvania, an area rich in scenic and recreational opportunities. Cooperative research opportunities will be welcomed by the Allegheny National Forest and other local and regional entities.

Please send a letter of application and three letters of reference by November 15 to: Dr. Edgar Hopkins, Chairman, Search Committee, University of Pittsburgh at Bradford, Bradford, PA 16701. We will be interviewing at the GSA meeting in Cincinnati.

UPB is an equal opportunity/affirmative action employer.

The SEATTLE/BELLEVUE, WA office of CH2M HILL, an employee-owned, multi-discipline Consulting Engineering firm with regional and project offices throughout North America and Overseas, has this career opportunity:

GEOHYDROLOGIST

Position requires a BS in Geology and a MS in Groundwater Hydrology or Hydrogeology. Engineering curricula equivalents acceptable. A thorough understanding of geology, aquifer mechanics, geochemistry, and computer modeling. Must have interest in project management, business development, and work in a team concept situation. Prefer a minimum of 5 years Consulting Engineering experience and total professional experience of 7 to 12 years. Qualifications should include working experience in:

- Groundwater Resource Evaluation and Supply Design
- Groundwater Quantity and Quality Monitoring Program Design and Implementing
- Groundwater Quantity and Quality Modeling

Salary commensurate with experience, excellent fringe benefits. An Equal Opportunity Employer. Send resume, in confidence, to Staff Manager GEOHY-3, CH2M HILL, P.O. Box 428, Corvallis, OR 97339.

CH2M HILL • Engineers • Planners • Economists • Scientists

University of Zimbabwe

Applications are invited for the following post:

LECTURESHIP/ SENIOR LECTURESHIP

Physics (Geophysics)
(available 1/2/81)

• SALARY SCALE

Lecturer Grade II:	$7,008 × 504 - 9,528 - $12,168
Lecturer Grade I:	$12,720 × 528 - $14,832
Senior Lecturer:	$14,040 × 528 - 15,624 × 540 - $16,324

• CONDITIONS OF SERVICE

Both permanent pensionable terms and short-term contracts are offered for academic posts.

• VACANCY

It is intended that the advertised post will be filled by a geophysicist (i.e. a physicist whose interests lie in the earth sciences). Preference will be given to applicants with experience in exploration geophysics who will be able to play a major part in the running of the MSc course in Exploration Geophysics starting in March, 1983. However, applicants with interests in other parts of geophysics, e.g. paleomagnetism, will be considered. Should such an applicant be appointed he will be expected to take part in the teaching of the MSc course.

• FURTHER PARTICULARS

Further particulars on the above posts, on conditions of service and method of application should be obtained prior to submitting an application from:

Director, Appointments & Personnel,
University of Zimbabwe
P.O. Box MP 167
Mount Pleasant, Salisbury
Zimbabwe.

Applications should be submitted by November 15, 1981.

Faculty Position in Watershed Hydrology. The School of Forestry and Environmental Studies at Duke University invites applications for both tenure-track and research appointments in watershed hydrology. Joint appointment with other university departments is possible.

Applicants should have background in physical and biological processes important in watershed hydrology, impact of land use on water quantity and quality, and quantitative methods including statistics, systems analysis, simulation. Requires Ph.D. with one degree in a natural resource area.

Write for position announcement or submit curriculum vitae, representative publications, three references by December 15 to: Chairman, Faculty Council, School of Forestry and Environmental Studies Box EA, Duke University, Durham, NC. 27706.

Duke University is an equal opportunity/affirmative action employer.

Postdoctoral Research Fellowships/Caltech. The Division of Geological and Planetary Sciences at the California Institute of Technology expects to offer postdoctoral research fellowships in one or more of the following areas: geology, geophysics, geochemistry, and planetary science. Interested persons are asked to contact: Dr. Barclay Kamb, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91125.

An equal opportunity/affirmative action employer.

Research Position in Chemical Oceanography. California Institute of Technology, Division of Geological and Planetary Sciences. The position of research fellow is being offered at Caltech for research in oceanography. Investigation of the isotopic composition of neodymium and rare earth abundances in sea water and sediments is now being carried forward. The mechanism of injection of REE into sea water will be studied. The differences in $^{143}Nd/^{144}Nd$ in various water masses (Piepgras et al., Earth and Planet Sci. Lett. 45, 223–236 and Piepgras and Wasserburg, Earth and Planet. Sci. Lett. 50, 128–138 (1980)) is now being carried forward as an exploratory venture in order to determine the origin and chemical behavior of REE in the ocean and the potential use of $^{143}Nd/^{144}Nd$ as a tracer. The laboratory facilities for sample preparation and analysis are fully functional and will be available. Applicants should have training in oceanography and a good perspective on general physical oceanographic models.

Send resume and references to Professor G. J. Wasserburg, Lunatic Asylum, California Institute of Technology, Pasadena, CA 91125.

Caltech is an equal opportunity/affirmative action employer (M/F/H).

Position in Reflection Seismology/Rice University, Houston, Texas. The Department of Geology plans to expand its geophysical program. Emphasis will be on reflection seismology. At this time applications are for the first of two open faculty positions. The successful applicant will help in the search for and selection of the second faculty member.

Your main responsibility will be to lead our department into the area of modern reflection seismology. Your main teaching and research interests should be in the acquisition and processing of reflection seismic data. You should also help in developing rigorous undergraduate and graduate curricula, which are supported by the traditional strength of the Math Sciences, Physics, and Electrical Engineering Departments at Rice. Enthusiasm to work with and undertake some joint projects with our geologists is essential.

Our plans are to acquire a computer system configured for high quality data processing. Substantial seed money for this facility is already in hand. Creative cooperation with the oil and geophysical industry in Houston, including a reasonable amount of consulting, is encouraged. Salary will be commensurate with qualifications and experience. Please send your curriculum vitae, a summary of experience in seismic processing, a statement of research interests, and names of three or more references to Dr. A. W. Bally, Chairman, Department of Geology, Rice University, P.O. Box 1892, Houston, Texas 77001. Application deadline—December 1, 1981.

Rice is an equal opportunity employer.

Assistant Professorships/University of Virginia. The Department of Environmental Sciences, University of Virginia invites applications for three tenure track assistant professorships beginning September 1982:

—*Climatology meteorology*
—*Environmental chemistry/geochemistry*
—*Water resources hydrology*

Applicants should have a Ph.D. and expect to teach undergraduate and graduate level courses in their area of specialization and to pursue a vigorous research program within the context of an interdisciplinary department. A curriculum vitae, a brief statement of research interests and names of three individuals who may be contacted for references, should be sent to George M. Hornberger, Department of Environmental Sciences, Clark Hall, University of Virginia, Charlottesville, Virginia 22903.

The University of Virginia is an equal opportunity/affirmative action employer.

Geophysics

University of Colorado

The Department of Physics, University of Colorado at Boulder, and the Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado/NOAA are currently recruiting for a tenure track faculty member, in the Department of Physics, with simultaneous appointment as a Fellow of CIRES, who will complement the Department's active role in the University's Interdepartmental Graduate Program in Geophysics. We are particularly (but not exclusively) seeking persons with experience and interest in the areas of space geodesy, geodynamics, or related areas of theoretical geophysics.

Appointment will be at the level of assistant professor (minimum salary: $20,000 per academic year) and is expected to start in the fall of 1982. The appointment entails full participation in the Department's undergraduate and graduate teaching programs (including offerings in the appointee's specialty), supervision of graduate students in appropriate areas, and the development of an active research program.

Candidates should send a letter of interest, a current curriculum vitae, and have three letters of reference sent no later than 1 January 1982 to:

Chairman
Department of Physics
Campus Box 390
University of Colorado
Boulder, Colorado 80309.

The University of Colorado is an affirmative action/equal opportunity employer.

COURSES

Course No. 450: Clouds: Their Formation, Properties and Effects, Pasadena, CA. NOV 30-DEC 4, 1981. The course is designed to provide a basic understanding of the concepts and an overview of the dynamical and micro-physical processes involved in the formation of air pollution. The results of recent studies of clouds on other planets will also be discussed. The course is especially structured to benefit those scientists whose main area of expertise is not in clouds but who wish to be brought abreast of current studies in this subject. Instructors will be Drs. P. Hobbs, C. Leovy, H. D. Orville, B. Scott, T. Vonder Haar, and E. J. Zipser. Registration fee is $590.

A Certificate of Course Completion will be awarded to those who complete the course. For further information contact Diana McQuestion, Course Coordinator, IFAORS, P.O. Box P, Hampton, Virginia 23666 (Tel: 804/827-5811).

SERVICES

PETROLEUM DEPOSITS. If you are financing, planning, designing, exploring, drilling, or digging in connection with any form of energy, you need this complete, up-to-date book about the world's petroleum deposits. Includes production and reserves for areas. Hardcover, 6 × 9 inches, 378 pages. Table of contents, drawings, index, references, 1974. $59. Tetsch Associates, 129 Thunder Road, Sudbury, MA 01776

STUDENT OPPORTUNITIES

Earth Sciences Assistantships and Fellowships. Research assistantships and fellowships are available to graduate students in the earth sciences from the Columbia University Department of Geological Sciences. The awards cover tuition and fees, and provide a yearly stipend of between $6400 and $8180.

Research is carried out at affiliated institutions including the Lamont-Doherty Geological Observatory, the Goddard Institute for Space Studies, and the American Museum of Natural History. Research topics available to students reflect the interests of the more than 300 Ph.D.-level scientists at these institutions and span virtually every area of the earth sciences.

The department encourages applications from students with an undergraduate degree in any of the natural sciences or engineering. For additional information please contact Ms. Mia Leo, Department of Geological Sciences, Columbia University, Lamont-Doherty Geological Observatory, Palisades, New York, 10964.

Graduate Research Assistantships in Physical Oceanography. Opportunities for graduate study with Research assistantship available for students interested in M.S. or Ph.D. programs. A summer program with stipend is open to college juniors. Write: Douglas Caldwell, School of Oceanography, Oregon State University, Corvallis, OR 97331.

GAP

Separates

High-quality reprints of individual articles from AGU journals are available in limited quantities. The separates program is designed to provide you with single articles for your personal use. Small quantity purchases for classroom use or library reserve copies for classes are available while supplies last; send your request on department stationery giving the class title and number of enrolled students. Quantity orders for resale or redistribution will not be filled.

To Order: The order number can be found at the end of each abstract; use all digits when ordering. Only papers with order numbers are available from AGU.

Cost: $3.50 for the first article and $1.00 for each additional article in the same order. Payment must accompany order.

Deposit Account: A minimum of $10.00 may be placed on deposit with AGU for the purchase of separates. If funds are on deposit, the cost of the first article is only $2.00 and $1.00 for each additional article in the same order.

Separates will be mailed within 3 weeks of journal publication or within 10 days if ordered after the journal has appeared. Separates are available for purchase for two years from date of publication.

Copies of English translations of articles from Russian translation journals are available either in unedited form at the time of their listing in EOS or in final printed form when a journal is published. The charge is $2.00 per Russian page.

Send your order to:
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

Oceanography

4312 Crop response function
LINEAR CROP RESPONSE FUNCTIONS TO SOIL SALINITY WITH A THRESHOLD SALINITY LEVEL
B. Yaron (Department of Soil and Environmental Sciences, UC Riverside, Riverside, CA 92521, U.S.A.) D. Yaron and E. Bresler
The response function of a crop yield to soil-salinity level is essential in decision [illegible]

[illegible]

4705 [illegible]
[illegible]
J. Geophys. Res., Green, Paper 1C1340

4713 Circulation
[illegible]
J. Geophys. Res., Green, Paper 1C1344

4713 Circulation
[illegible]
J. Geophys. Res., Green, Paper 1C1347

4720 Distribution and water masses
THE RESIDENCE TIME OF THE FRESHWATER COMPONENT IN ARCTIC OCEAN
[illegible]
J. Geophys. Res., Green, Paper 1C1437

4730 Internal Waves
[illegible]
J. Geophys. Res., Green, Paper 1C1342

4799 General oceanography
THE SEASAT ALTIMETER [illegible]
[illegible]
J. Geophys. Res., Red, Paper 1R1337

Particles and Fields—Magnetosphere

1120 Interactions between solar wind and magnetosphere
RELATIONSHIPS BETWEEN THE SOLAR WIND ELECTRIC FIELD AND THE MAGNETOSPHERIC CONVECTION ELECTRIC FIELD
[illegible], S. Gendrin, [illegible], and J. [illegible]
[illegible]
Geophys. Res. Lett., Paper 1L1319

5705 Magnetospheric configuration
MAGNETIC FIELD LINE RECONNECTION EXPERIMENTS, PART 3: ION ACCELERATION, FLOWS, AND ANOMALOUS SCATTERING
W. Gekelman, R. L. Stenzel, and N. Wild (UCLA Department of Physics, Los Angeles, CA 90024)
Space and time resolved measurements of the fluid velocity have been performed in a laboratory plasma undergoing magnetic field line reconnection. [illegible]

5755 Plasma instabilities
[illegible]
Geophys. Res. Lett., Paper 1L1306